CLAIMS

1. A bidirectional isolating device (10, 70, 107, 108) comprising at least a first non-reciprocal optical assembly, said assembly comprising:
   - at least a first polarizer (12, 51, PBS1);
   - at least a first non-reciprocal polarization rotator (14, 53, FR1), arranged for rotating a polarization of a signal of substantially $45° \pm k{\cdot}90°$, wherein k is a non-negative integer;
   - at least a first wavelength selective reciprocal polarization rotator (13, 54, WSR1), having a half-wave retarder behavior for a first group of optical frequencies and a full-wave retarder behavior for a second group of optical frequencies, according to a substantially frequency periodic transfer function;

   characterized in that
   - said first wavelength selective reciprocal polarization rotator comprises a predetermined number of at least five birefringent elements having a predetermined thickness and orientation, said number, thickness and orientation being adapted for obtaining a transition between the half-wave retarder behavior and the full-wave retarder behavior in a frequency range lower than or equal to the 40% of the period of said transfer function.

2. A bidirectional isolating device according to claim 1, characterized in that said optical assembly further comprises at least a first non-wavelength selective reciprocal polarization rotator (52, RR1), said polarizer, said non-reciprocal polarization rotator, said first non-wavelength selective reciprocal polarization rotator and said first wavelength selective reciprocal polarization rotator being arranged within said assembly so that a first optical signal having frequency in said first group of optical frequencies a second optical signal having frequency in said second group of optical frequencies, input at said polarizer with whatever polarization, exit from said assembly so that the first optical signal is in a first polarization state and the second optical signal is in a second polarization state, orthogonal to said first polarization state.

3. A bidirectional isolating device according to any one of claims 1 or 2, characterized in that said number, thickness and orientation of said birefringent

elements is adapted for obtaining a transition between the half-wave retarder behavior and the full-wave retarder behavior in a frequency range lower than or equal to the 20% of the period of said transfer function.

4. A bidirectional isolating device according to any one of claims 1 to 3, characterized in that at least all but one of said birefringent elements have substantially the same thickness.

5. A bidirectional isolating device according to claim 4, characterized in that said birefringent elements have all substantially the same thickness.

6. A bidirectional isolating device according to any one of claims 4 or 5, characterized in that said birefringent elements having substantially the same thickness have a thickness variation of less than or equal to 1%.

7. A bidirectional isolating device according to any one of claims 4 to 6, characterized in that said birefringent elements having substantially the same thickness are disposed so that elements having a lower thickness alternate to elements having a higher thickness.

8. A bidirectional isolating device according to any one of claims 1 to 7, characterized in that said polarizer is adapted for splitting an optical signal having any polarization into two signal portions propagating onto two separate optical paths, with orthogonal polarizations.

9. A bidirectional isolating device according to claim 8, characterized in that it further comprises at least a second polarizer, adapted for coupling said two signal portions having orthogonal polarizations on a single optical path.

10. A bidirectional isolating device according to any one of claims 2 to 7 characterized in that it further comprises at least a second optical assembly including a second polarizer (PBS2), a second non-reciprocal polarization rotator (FR2), a second non-wavelength selective reciprocal polarization rotator (RR2) and a second wavelength selective reciprocal polarization rotator (WSR2) having a half-wave behavior for a third group of frequencies and full-

wave behavior for a fourth group of frequencies, said second polarizer, said second non-reciprocal polarization rotator, said second non-wavelength selective reciprocal polarization rotator and said second wavelength selective reciprocal polarization rotator being arranged within said second assembly so that a third optical signal having frequency in the third group of frequencies and a fourth optical signal having frequency in the fourth group of frequencies, input at said second polarizer with whatever polarization, exit from said second assembly so that the third optical signal is in a third polarization state and the fourth optical signal is in a fourth polarization state, orthogonal to said third polarization state, said first and second assemblies being optically coupled to a splitting component (75, PBS3).

11. A bidirectional isolating device according to claim 10, characterized in that said first wavelength selective reciprocal polarization rotator (WSR1) has a transition between said full wave behavior and said half wave behavior at a first transition frequency, and said second wavelength selective reciprocal polarization rotator (WSR2) has a transition between said full wave behavior and said half wave behavior at a second transition frequency, different from said first transition frequency.

12. A bidirectional isolating device according to claim 10, comprising a first branch (73a), a second branch (74a), a third branch (71a) and a fourth branch (72a), optically coupled to a splitting component (75), characterized in that:
   - said first branch (73a) includes said first assembly (PBS3, RR3, FR3, WSR3);
   - said second branch (74a) includes said second assembly (PBS4, RR4, FR4, WSR4);
   - said third branch (71a) includes a third assembly comprising a third polarizer (PBS1), a third reciprocal polarization rotator (RR1) and a third wavelength selective reciprocal polarization rotator (WSR1);
   - said fourth branch includes a fourth assembly comprising a fourth polarizer (PBS2), a fourth reciprocal polarization rotator (RR2) and a fourth wavelength selective reciprocal polarization rotator WSR2);
   - said first, second, third and fourth wavelength selective reciprocal polarization rotators (WSR1, WSR2, WSR3, WSR4) all have a half-

wave behavior for said first group of frequencies and a full-wave behavior for said second group of frequencies:

- said third and said fourth assemblies are reciprocal and are arranged such that said first optical signal and said second optical signal, input at said third or fourth polarizer with whatever polarization, exit from said third or fourth assembly so that the first optical signal is in a first polarization state and the second optical signal is in a second polarization state, orthogonal to said first polarization state.

13. A bidirectional isolating device according to claim 1, comprising a first branch (71a), a second branch (72a), a third branch (73a) and a fourth branch (74a), optically coupled to a splitting component (75), characterized in that:

- said first branch (71a) is non-reciprocal and includes said first polarizer (PBS1), said first non-reciprocal polarization rotator (FR1) and a first non-wavelength selective reciprocal polarization rotator (RR1), being arranged such that any optical signal, input at said first polarizer with whatever polarization, exits from said first branch in a first polarization state;
- said second branch (72a) is non-reciprocal and includes a second polarizer (PBS2), a second non-reciprocal polarization rotator (FR2) and a second non-wavelength selective reciprocal polarization rotator (RR2), being arranged such that any optical signal, input at said second polarizer with whatever polarization, exits from said second branch in a second polarization state, orthogonal to the first state;
- said third branch (73a) is reciprocal and includes said first wavelength selective reciprocal polarization rotator (WSR3), a third non-wavelength-selective reciprocal polarization rotator (RR3) and a third polarizer (PBS3), being arranged such a first optical signal having frequency in said first group of frequencies and a second optical signal having frequency in said second group of frequencies, input at said third polarizer with whatever polarization, exit from said third branch so as the first optical signal is in said first polarization state and the second optical signal is in said second polarization state;
- said fourth branch (74a) is reciprocal and includes a second wavelength selective reciprocal polarization rotator (WSR4), a fourth

non-wavelength-selective reciprocal polarization rotator (RR4) and a fourth polarizer (PBS4), being arranged such that said first optical signal and said second optical signal, input at said fourth polarizer with whatever polarization, exit from said fourth branch so as the first optical signal is in said first polarization state and the second optical signal is in said second polarization state.

14. An optical amplifier (30, 40, 100) comprising:
   - at least a first optical amplifying medium (31, 41, 42, 101, 102);
   - a pumping system suitable for generating a pumping power and for providing such pumping power to said first optical amplifying medium;
   - a bidirectional isolating device (34a, 34b, 45, 107, 108) according to any one of claims 1 to 13.

15. An optical amplifier according to claim 14, characterized in that it further comprises at least a second optical amplifying medium (42, 102), said pumping system being suitable for providing said pumping power also to said second amplifying medium (42, 102), said bidirectional isolating device (45, 107, 108) being disposed between said first (41, 101) and second amplifying medium (42, 102).

16. An optical amplifier according to claim 14 or 15, characterized in that said first or second optical amplifying medium comprise a rare-earth doped fiber.

17. An optical amplifier according to claim 14 or 15, characterized in that said first or second optical amplifying medium comprise a Raman-active optical fiber.

18. An optical amplifier according to claim 15 and 17, said optical amplifier being adapted for transmitting and amplifying an optical signal having frequency in said first group of frequencies in a first direction from said first Raman-active fiber to said second Raman-active fiber, characterized in that:
   - said pumping system comprises at least one pump source (43, 104) adapted for providing a first pumping radiation having frequency included in said second group of frequencies, said first pumping

radiation being adapted for causing Raman amplification of said first group of signals at least in said second Raman-active optical fiber (42, 102);

- said pumping system further comprises at least one coupler (44, 106), one end of said second Raman-active fiber (42, 102) being optically connected to a first port of said coupler (44, 106) and said at least one pump source (43, 104) being optically connected to a second port of said coupler (44, 106), so that said first pumping radiation may propagate in at least said second Raman-active fiber (42, 102) in a second direction, opposite to said first direction.

19. An optical amplifier according to claim 18, characterized in that said bidirectional isolating device (45, 107) is adapted for passing said first pumping radiation from said second Raman-active fiber (42, 102) to said first Raman-active fiber (41, 101).

20. An optical amplifier according to claim 17 or 18, characterized in that:
   - said pumping system comprises at least a second pump source (103) adapted for providing a second pumping radiation having a frequency included in a third group of frequencies, said second pumping radiation being adapted for causing Raman amplification at least of said first group of signals in said first Raman-active optical fiber (101);
   - said bidirectional isolating device (108) is adapted for coupling said second pumping radiation into said first Raman-active fiber (101) in a second direction, opposite to said first direction.

21. An optical amplifier according to claim 20, characterized in that said bidirectional isolating device (108) is further adapted for extracting a residual of said first pumping radiation coming out from said second Raman-active fiber (102).